CLAIMS

What is Claimed is:

1. A method for detecting a threshold temperature in an integrated circuit comprising the steps of:

generating a constant current source from a power supply;

generating a voltage reference from said constant current source wherein said voltage reference is substantially constant over a range of temperatures of said integrated circuit and a range of power supply voltages;

generating a sensing voltage wherein said sensing voltage amplitude exhibits a linear relationship with said temperature of said integrated circuit;

scaling said sensing voltage to generate a comparison voltage such that when said integrated circuit attains said threshold temperature said comparison voltage is substantially equal to said voltage reference;

comparing said reference voltage to said comparison voltage; and

generating a signal when said comparison voltage exceeds said reference voltage to indicate said integrated circuit temperature surpassed said threshold temperature.

2. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 1 further comprising the step of programming a threshold temperature by specifying a scale factor for scaling said sensing voltage.

3. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 2 wherein:

the step of generating a constant voltage reference comprises the step of generating a silicon bandgap voltage reference; and

the step of generating a sensing voltage comprises the step of generating a base to emitter voltage (V_{be}) from a bipolar transistor.

4. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 3 wherein the step of scaling said sensing voltage comprises the step of providing a plurality of resistors, wherein a first resistive element is coupled from the base to the collector of said bipolar transistor, and a second resistive element, comprising at least one resistor, is coupled from the base of said bipolar transistor to ground, wherein said first resistive element and said second resistive element generate a scale factor for scaling said sensing voltage.

5. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 4 wherein the step of programming a threshold temperature by specifying a scale factor comprises the steps of:

coupling metal oxide semiconductor field effect transistors (MOSFETs) in parallel for each resistor comprising said second resistive element; and

biasing said MOSFETs so as to select a combination of said resistors in said second resistive element so as to specify said scale factor for scaling said sensing voltage.

6. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 4 wherein said at least one resistor comprising said second resistive element is binary weighted.

7. The method for detecting a threshold temperature in an integrated circuit as claimed in claim 1 wherein said integrated circuit comprises a microprocessor.

8. An apparatus for detecting a threshold temperature in an integrated circuit comprising:

current source means for generating a constant current source;

voltage reference means coupled to said constant current source means for generating a voltage reference from said constant current source wherein said voltage reference is substantially constant over a range of temperatures of said integrated circuit;

temperature sensing means for generating a sensing voltage wherein said sensing voltage amplitude exhibits a linear relationship with said temperature of said integrated circuit, said temperature sensing means including scaling means for scaling said sensing voltage to generate a comparison voltage such that when said integrated circuit attains said threshold temperature said comparison voltage is substantially equal to said voltage reference; and

comparison means coupled to said temperature sensing means and said voltage reference means for comparing said reference voltage to said comparison voltage, and generating a signal when said comparison voltage exceeds said reference voltage to indicate said integrated circuit temperature attained said threshold temperature.

9. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 8 further comprising programming

means for programming a threshold temperature by specifying a scale factor for scaling said sensing voltage.

10. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 9 wherein:

said voltage reference means generates a silicon bandgap voltage reference; and

said temperature sensing means comprises a bipolar transistor for generating a base to emitter voltage (V_{be}) for said sensing voltage.

11. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 10 wherein said scaling means comprises a plurality of resistors, wherein a first resistive element is coupled from the base to the collector of said bipolar transistor, and a second resistive element, comprising at least one resistor, is coupled from the base of said bipolar transistor to ground, wherein said first resistive element and said second resistive element generate a scale factor for scaling said sensing voltage.

12. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 11 wherein said programming means comprises:

a plurality of metal oxide semiconductor field effect transistors (MOSFETs) coupled in parallel with each resistor comprising said second resistive element; and

biasing means for biasing said MOSFETs so as to select a combination of said resistors in said second resistive element to specify said scale factor for scaling said sensing voltage.

13. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in 11 wherein said at least one resistor comprising said second resistive element is binary weighted.

14. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in 8 wherein said integrated circuit comprises a microprocessor.

15. An apparatus for detecting a threshold temperature in an integrated circuit comprising:

a constant current source circuit;

a silicon bandgap reference circuit coupled to said constant current source circuit, said voltage reference circuit generating a silicon bandgap voltage reference, from said constant current source, wherein said silicon bandgap voltage reference is substantially constant over a range of temperatures of said integrated circuit;

a bipolar transistor wherein a base to emitter voltage (V_{be}) from said bipolar transistor generates a temperature sensing voltage of said integrated circuit, said current source circuit being coupled to a collector of said bipolar transistor;

a voltage divider circuit comprising a scale factor coupled to said bipolar transistor for scaling said V_{be} to generate a comparison voltage such

that when said integrated circuit attains said threshold temperature, said comparison voltage is substantially equal to said silicon bandgap voltage; and

a comparator coupled to said collector of said bipolar transistor and to said voltage reference circuit, said comparator comparing said silicon bandgap voltage to said comparison voltage, and generating a signal when said comparison voltage exceeds said silicon bandgap voltage to indicate said integrated circuit temperature attained said threshold temperature.

16. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 15 wherein said voltage divider circuit comprises a plurality of resistors, wherein a first resistive element is coupled from the base to the collector of said bipolar transistor, and a second resistive element, comprising at least one resistor, is coupled from the base of said bipolar transistor to ground, wherein said first resistive element and said second resistive element generate said scale factor for scaling said V_{be}.

17. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in claim 16 further comprising:

a plurality of metal oxide semiconductor field effect transistors (MOSFETs) coupled in parallel with each resistor comprising said second resistive element; and

a plurality of programming voltages input to said MOSFETs for biasing said MOSFETs so as to select a combination of said resistors in said second resistive element to specify said scale factor for scaling said sensing voltage.

18. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in 16 wherein said at least one resistor comprising said second resistive element is binary weighted.

19. The apparatus for detecting a threshold temperature in an integrated circuit as claimed in 15 wherein said integrated circuit comprises a microprocessor.

20. A microprocessor comprising:

processing means for executing a plurality of instructions, said processing means including programming means for generating a value representative of a threshold temperature for said microprocessor; and

programmable thermal sensor means coupled to said processing means for detecting temperature characteristics in said microprocessor, said thermal sensor means receiving said value for said threshold temperature and generating a detect signal when said microprocessor attains said threshold temperature.

21. The microprocessor as set forth in claim 20 further comprising fail safe sensor means, said fail safe sensor means comprising a pre-determined fail safe critical temperature and sensing said temperature of said microprocessor such that if said microprocessor attains said fail safe critical temperature, said fail safe sensor halts operation of said microprocessor.

22. The microprocessor as set forth in claim 20 wherein said processing means comprises interrupt means for changing control of execution of said instructions in said processing means based on an event,

and comprising a thermal sensor interrupt service routine, said detect signal of said thermal sensor being coupled to said interrupt means such that detection of said threshold temperature generates an interrupt in said processing means, and generation of said interrupt in said microprocessor invokes said thermal sensor interrupt service routine.

23. The microprocessor as set forth in claim 22 further comprising clock means coupled to said processing means for generating clock timing to provide timing for said processing means, said thermal sensor interrupt service routine controlling said clock means so as to reduce the frequency of said clock.

24. The microprocessor as set forth in claim 22 further comprising a fan coupled to said processing unit for cooling said microprocessor, said thermal sensor interrupt service routine activating said fan to cool said microprocessor.

25. The microprocessor as set forth in claim 20 further comprising clock control means coupled to said processing means including a clock for generating timing for said processing means and a counter for controlling the frequency of said clock, said programming means receiving said detect signal, and programming said clock control means so as to reduce the frequency of said clock when said thermal sensor means detects said threshold temperature.

26. The microprocessor as set forth in claim 20 wherein said programming means further includes reset means for programming said

thermal sensor after detection of a threshold temperature in said integrated circuit, said programming means receiving said detect signal and programming a value in said thermal sensor means indicating a new threshold temperature.

27. A microprocessor comprising:

a processing unit for executing operations in accordance with a plurality of instructions, said processing unit including a read only memory (ROM) storing a microprogram and an internal register, said microprogram generating representative of a threshold temperature for said microprocessor, and storing said value in said internal register; and

a programmable thermal sensor coupled to said processing unit for detecting temperature characteristics in said microprocessor, said programmable thermal sensor receiving said value from said internal register for said threshold temperature and transmitting a detect signal, to said ROM and said processing unit, when said microprocessor attains said threshold temperature.

28. The microprocessor as set forth in claim 27 further comprising a fail safe sensor comprising a pre-determined fail-safe critical temperature and sensing said temperature of said microprocessor such that if said microprocessor attains said fail safe critical temperature, said fail safe sensor halts operation of said microprocessor.

30. The microprocessor as set forth in claim 27 wherein said processing unit comprises an interrupt handler for changing control of execution of said instructions in said processing unit based on an event, and

an interrupt handler service routine, said detect signal of said thermal sensor being coupled to said interrupt handler such that detection of said threshold temperature generates an interrupt in said processing unit, and generation of said interrupt in said microprocessor invokes said thermal sensor interrupt service routine for controlling the temperature of said microprocessor.

31. The microprocessor as set forth in claim 30 further comprising a clock coupled to said processing unit for generating clock timing for said processing unit, said thermal sensor interrupt service routine controlling said clock so as to reduce the frequency of said clock timing.

32. The microprocessor as set forth in claim 30 further comprising a fan coupled to said processing unit for cooling said microprocessor, said thermal sensor interrupt service routine activating said fan to cool said microprocessor.

33. The microprocessor as set forth in claim 27 further comprising external sensor logic coupled to said processing unit and a counter coupled to said external sensor logic, and a clock to provide timing for said processing unit, said external sensor logic receiving said detect signal, and programming said counter to reduce the frequency of said clock when said thermal sensor means detects said threshold temperature.

34. The microprocessor as set forth in claim 27 wherein said microprogram further includes a reset function that programs said thermal sensor after detection of a threshold temperature, said microprogram

receiving said detect signal and programming a value in said thermal sensor means indicating a new threshold temperature.

35 A computer system comprising:

a microprocessor comprising;

a processing unit for executing operations in accordance with a plurality of instructions,

a thermal sensor programming circuit for generating a value representative of a threshold temperature for said microprocessor,

a programmable thermal sensor coupled to said processing unit for detecting temperature characteristics in said microprocessor, said programmable thermal sensor receiving said value from said thermal sensor programming circuit and transmitting a detect signal, said processing unit, when said microprocessor attains said threshold temperature,

an interrupt handler for changing control of execution of said instructions in said processing unit based on an event,

an output display device including an input/output (I/O) coupled to said microprocessor for displaying pixels; and

a memory coupled to said microprocessor for storing said plurality of instructions and data, said plurality of instructions including an interrupt service routine and an operating system, said interrupt handler in said microprocessor receiving said detect signal and calling said interrupt service routine, and said interrupt service routine generating a message indicating the microprocessor attained said threshold temperature, said message being displayed to said output display via said operating system.

36. The computer system as set forth in claim 35 wherein said microprocessor further comprises a fail safe sensor comprising a pre-determined fail safe critical temperature and sensing said temperature of said microprocessor such that if said microprocessor attains said fail safe critical temperature, said fail safe sensor halts operation of said microprocessor.